Space Weather Technical Forecast

Issued on Monday, 02 October 2023 at 01:09 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares throughout. Slight chance of isolated G1/Minor Storm interval, mainly day 1 (02 Oct) or day 3 (04 Oct)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one M-class flare, peaking at M2.5 at 01/0132 UTC from AR3452 in the northeast. There are nine sunspot regions on the visible disc. AR3451 and AR3452 emerged through the last 48 hours as a closely coupled pair, with frequent C-flares and a couple of M-flares, including the previously mentioned one. Growth of AR3451, the northernmost one, has largely stalled, but is ongoing within the intermediate spots of AR3452. This has also seen consolidation of its leader and trailer spots. Of the other spots AR3450 in the southwest is the most notable with a moderately sized negative leader spot, and some slight complexity with mixed polarities amongst its intermediate spots.

No Earth-directed CMEs occurred.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, were indicated of slow wind conditions. Speeds were background to slightly elevated, at 390-430 km/s. Density was at or below average. The interplanetary magnetic field (IMF), Bt, was weak, below 6nT. The north-south component, Bz, has been variable in direction, varying between +5nT and -6nT. Phi angle was generally positive (away from the Sun). Resultant geomagnetic activity was mainly Quiet (Kp 1-2), but with one Active period (Kp 4) 01/0000-0300 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electrons were Background to Moderate, peaking 454 pfu. Associated 24-hour fluence was below Active (1e8 integrated pfu) threshold and declining. The observation at 02/0000 UTC was 1.21e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate with a chance of further isolated M-class flares. The main M-flare risk is currently from AR3450 and AR3452.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. The next notable enhancement is most likely day 1 (02 Oct) due to the arrival of the fast winds of CH54/+, perhaps increasing solar winds to around 500km/s, however this is low confidence due to the mid-high latitude location of the coronal hole. CH55/+ fast wind may then follow, perhaps day 2 (03 Oct) but most likely day 3 (04 Oct). While more likely to connect due to its location, this is a smaller and newer feature, with low confidence for the strength of any connection. MOSWOC Enlil suggest solar winds of around 450kms, are possible. Mainly Quiet geomagnetic activity expected with isolated Unsettled spells. Any fast wind arrival has the potential to bring a spell of Unsettled to Active, with a slight chance of G1 Minor Storm intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with no Solar Radiation storms expected. High energy electron flux (greater than 2MeV) observed by GOES16 is expected to vary between Background and Moderate levels on day 1 (01 Oct) and some of day 2 (02 Oct). Thereafter a

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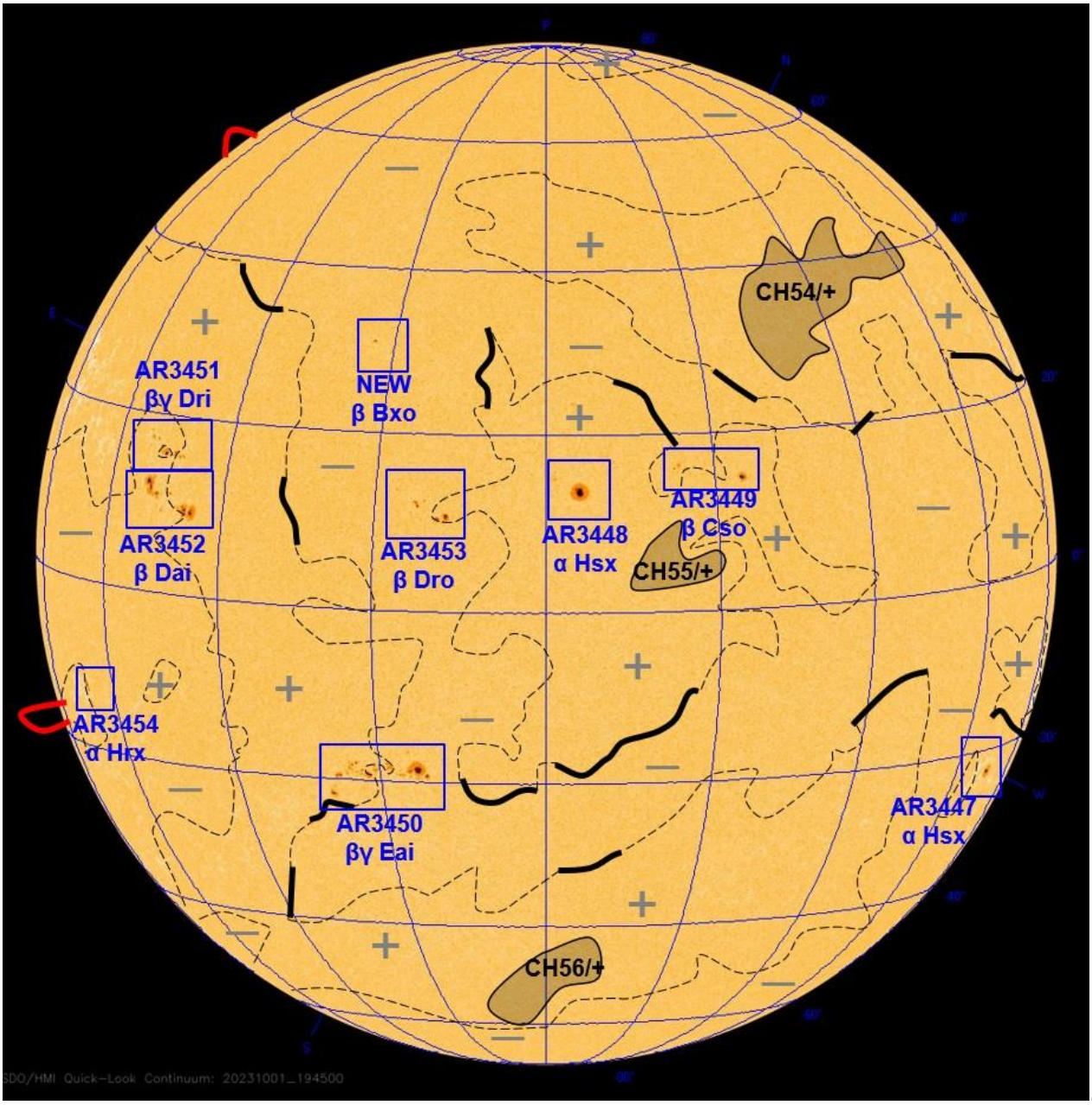
more significant drop-out of electron flux is forecast to occur, related to the onset of any fast winds. A slight recovery to Moderate, perhaps diurnally high levels is then possible by day 4 (05 Oct). Fluence is forecast to be below Active (above 1e8 integrated pfu) levels throughout.

Figure 1. Solar Analysis Valid 01/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

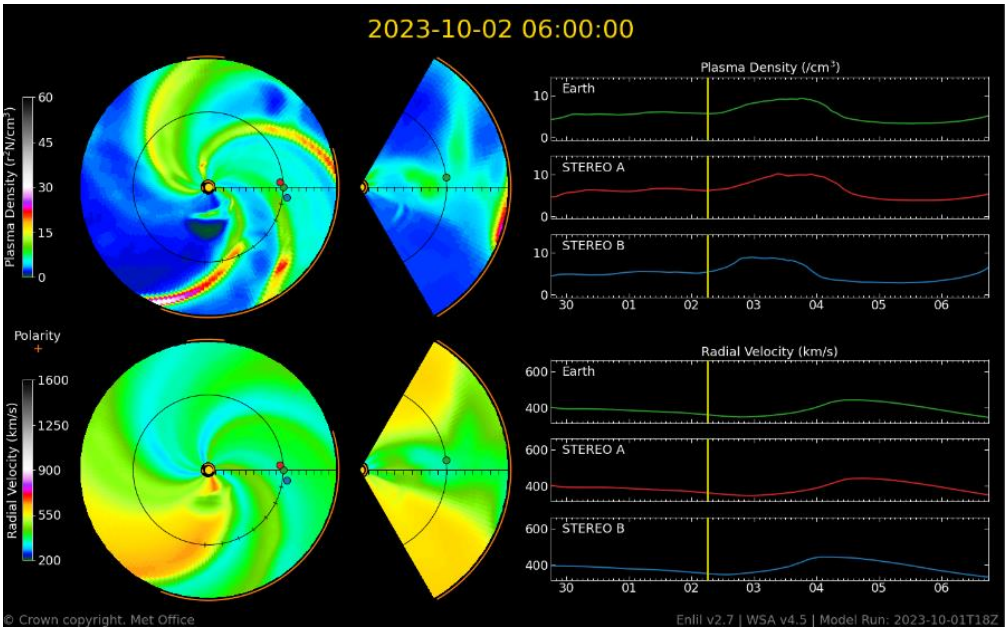
Solar winds are currently around background to slightly elevated levels, with Earth south of any notable fast wind influence from CH54/+. This is located at mid-high latitudes across the northwestern disc, although a southeastern extended lobe may allow for a transition into its fast wind on day 1 (01 Oct), perhaps bringing speeds up to around 500 km/s. However, this remains low confidence due to its northern latitude. Considering its positive polarity, then any connection that does occur is more favoured to be geoeffective this time of year.

Late on day 2 (03 Oct) or more likely on day 3 (04 Oct) a further transition into the fast wind from equatorial CH55/+ is then possible, as indicated in MOSWOC Enlil. This is a small, non-recurrent feature with low confidence for expected speeds, but may again increase solar winds to around 450km/s.

Mainly Quiet geomagnetic activity is expected for much of the period, with isolated Unsettled spells. However, any fast wind arrival has the potential to bring a spell of Unsettled to Active, with a slight chance of G1 Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Enlil showing weak enhancement day 3/4 (CH55) but has CH54 HSS north of Earth



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Radio Blackouts - X-Ray Flares:

Moderate to Low activity is expected, with an ongoing chance of isolated M-flares each day.

There are nine sunspot regions on the disc. The northeast disc has been the most active area over the previous 24 hours, with both AR3451 and AR3452, the latter of which was the source of the only M-flare that occurred. However, growth of AR3451 has now largely stalled, while AR3452 has seen some further flux emergence, but also spreading and consolidation of its spots perhaps suggesting some maturing of both of these features.AR3450 in the southeast has also seen some slight growth in intermediate spots, and further spreading of its leader and trailer. This region has produced a previous M-flare, on 28 Sep, and further flaring remains possible.

The other regions are generally smaller, simpler, and either stable or showing sign of decay. The main exception is AR3453 which emerged the last 24 hours, however this appears to have stabilised to also be a relatively small and simple region.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	55	55	50	45
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES16 X-ray flux

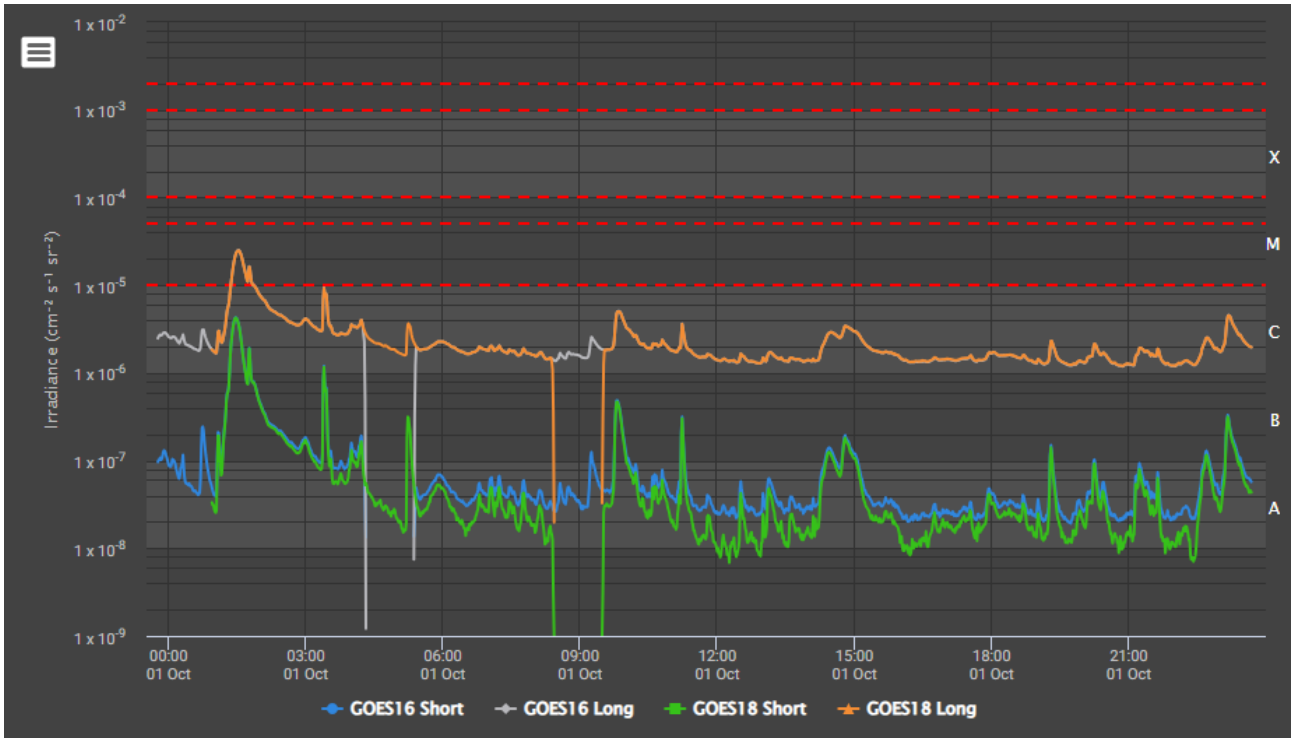

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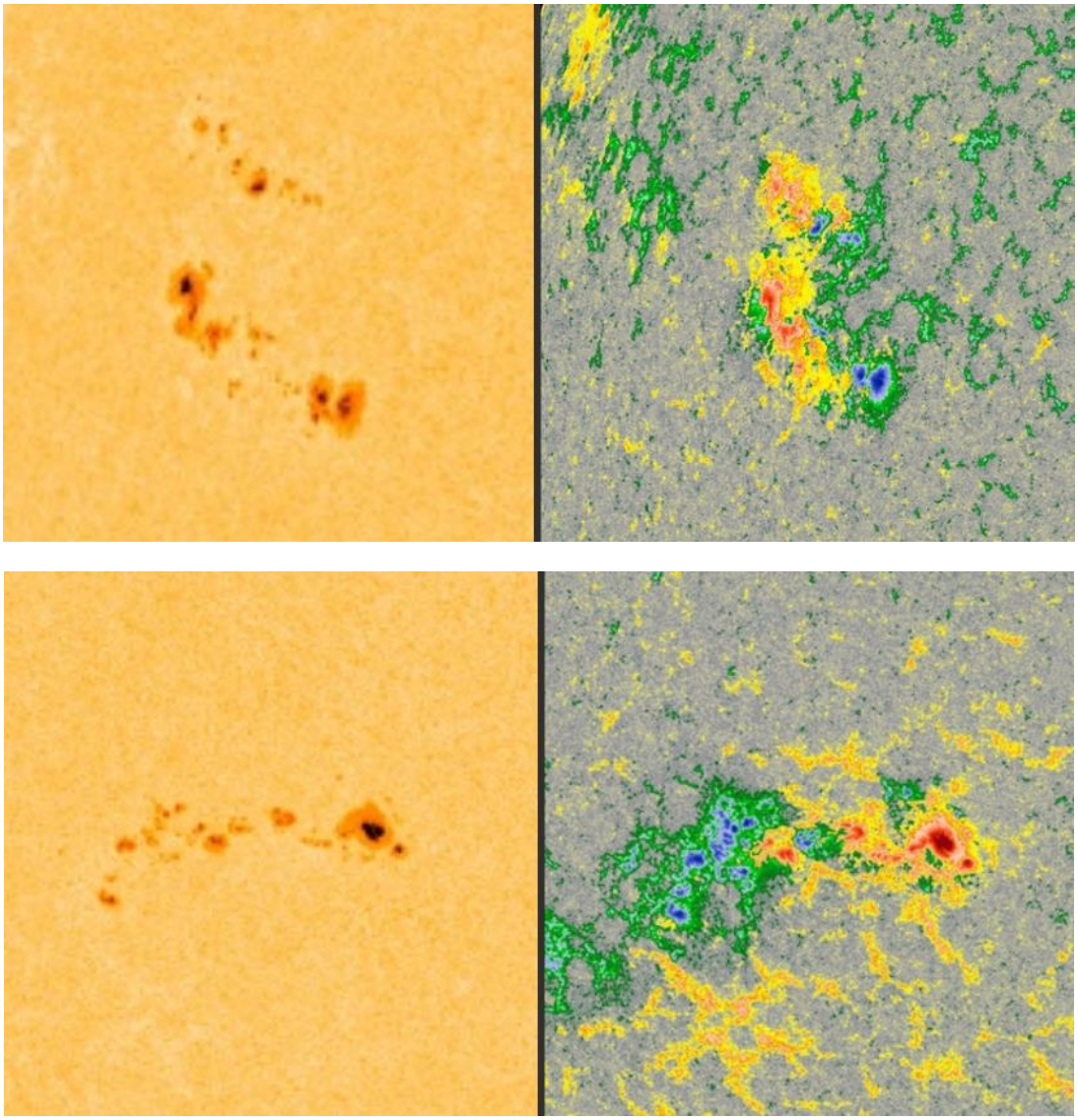
Figure 4: SDO Intensitgram (left) and Magnetogram (right) of AR3451/52 (top) and AR3450 (bottom)



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels, with the current sunspots on the disc not expected to produce proton events.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16, is Background to Moderate, having now declined after the previous enhancement. This is likely to drop out to background if any connection to CH54 occurs day 1 (02 Oct), or due to any connection to CH55 either late day 2 or more likely day 3 (03-04 Oct). A recovery in flux is then possible later day 3 or day 4 (04-05 Oct) to mainly Moderate with a chance of peaking at High during diurnal maximum.

The associated 24 fluence is expected to remain below the Active threshold, with a generally declining trend. This is in agreement with REFM although the model is currently overestimating the current fluence. As any coronal hole enhancement eases day 3 onward, there is a chance of fluence increasing again, but is currently expected to remain below Active.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES 16/18 >2MeV Electron Flux (top) and fluence with REFM (bottom)

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